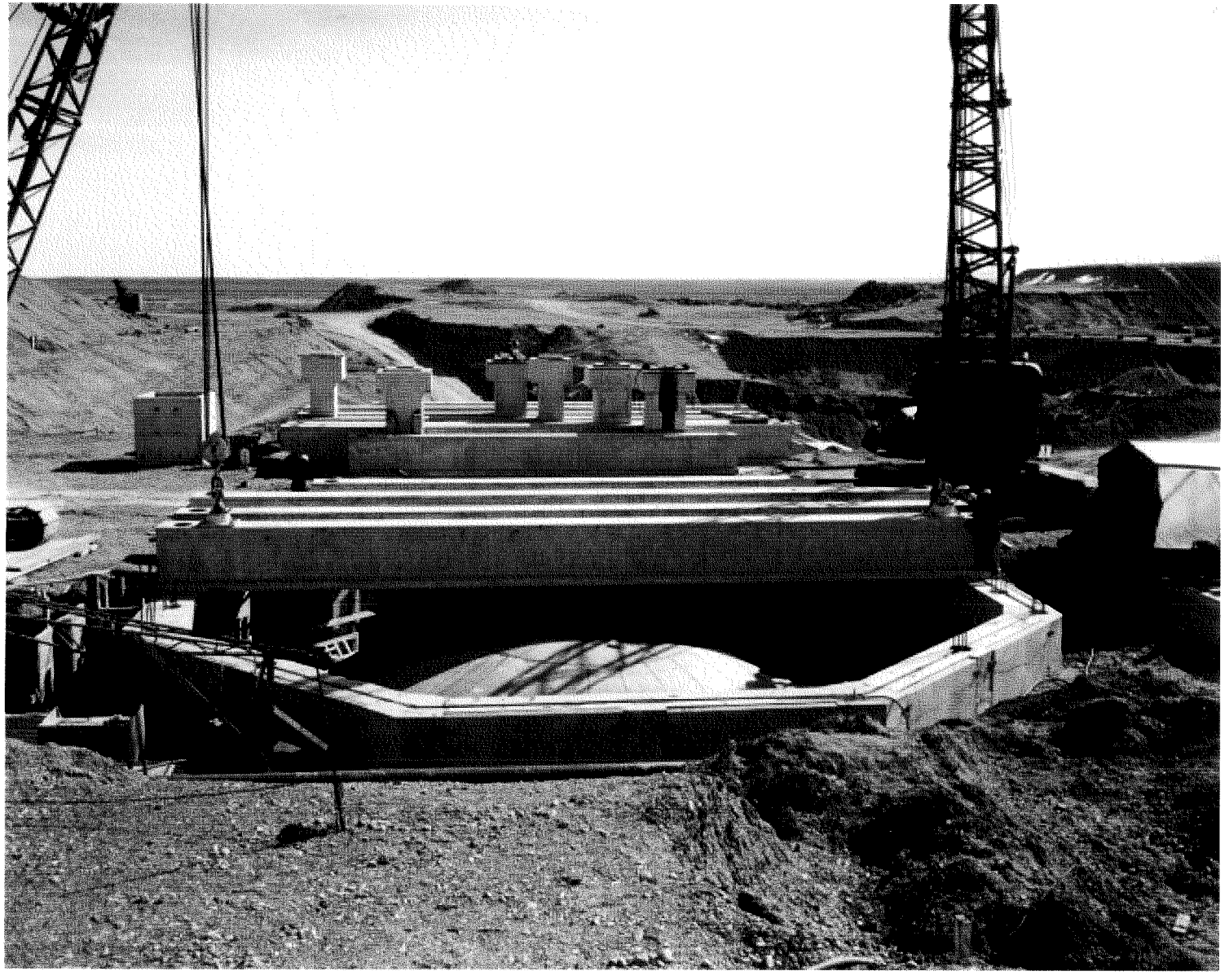

Figure 2-10. Vault and dome of WM-185, with the concrete beams and concrete risers on top.

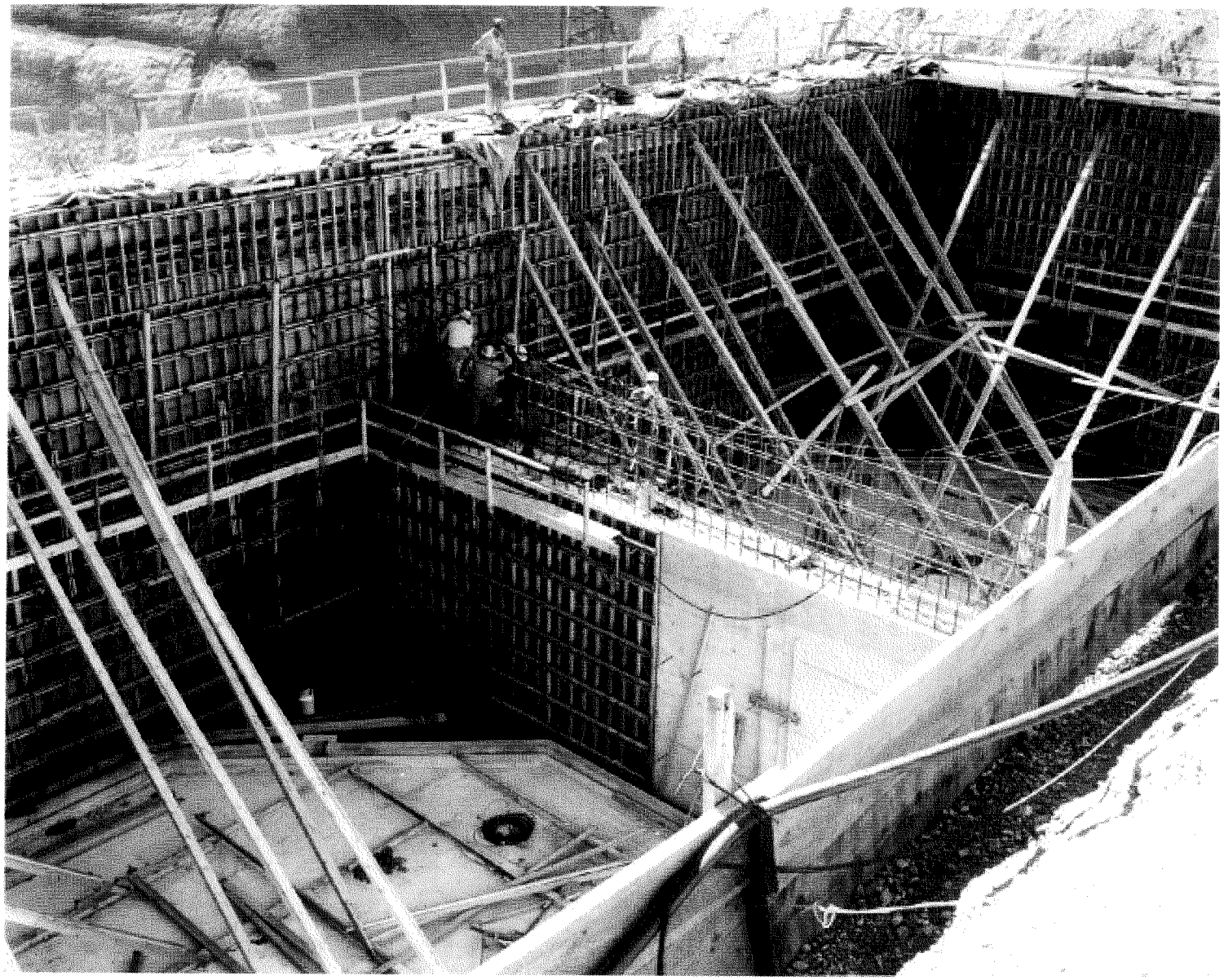

Figure 2-11. Monolithic square vault for WM-190 (forefront) and WM-189.

Each tank vault floor is cast with liquid collection sumps varying in size and capacity. The number of sumps per vault and the respective capacities include the following:

- Vaults for WM-180 and -181 each contain one leak detection sump (120 gal).
- Vaults for WM-182 through -188 each have two hot sumps (7.5 gal each).
- Vaults for WM-189 and -190 each have two hot sumps (22.5 gal) and one larger cold sump (1,011 gal).

Initially, tank vault sumps for WM-180 and WM-181, equipped with liquid-level sensors, could only transfer vault sump liquid to the alternate tank and not back to the respective tank. The subsequent vault and tank series, WM-182 through WM-184, were constructed with a portable, high-pressure steam source that could attach to an abovegrade hose connection leading from each vault sump jet. This enabled sump liquid to be transferred to the respective tank. These vaults were also equipped with liquid-level sensors.

When tanks WM-185 and WM-186 and WM-187 through WM-190 were constructed, their respective vaults were equipped with permanent liquid transfer steam jets (also called jet pumps) and liquid-level sensors. The preceding vaults, for tanks WM-180 through WM-184, were then retrofitted with permanent liquid transfer steam jets.

Figures 2-12 through 2-14 show, respectively, the tank vault sump schematic for WM-180 and WM-181, for tanks WM-182 through WM-186, and for tanks WM-187 through WM-190.

Subsequent upgrades installed an additional transfer jet in each vault to allow one sump the capability of jetted sump liquid to a centralized line leading to the PEW evaporator feed collection tanks in CPP-604 (WL-102 and WL-133). Figure 2-15 shows a simplified schematic of the centralized line.

The vault construction for tanks WM-182 through WM-190 have a conical bottom with a 4-in. slope. A 6 × 6-in. curb creates a 51-ft-diameter barrier encircling a sand pad (see Figure 2-16). The sand pad was designed to cushion the tank bottom. The sand is 6 in. deep at the curb and about 2 in. deep at the apex. These 300,000-gal storage tanks were then assembled on the sand pad within the vault.

2.4.2 Past Tank Composition and Usage

The composition of the liquid waste present at any time in the 300,000-gal tanks fluctuated with the intermittent input of liquid waste from multiple INTEC operations. In 1998, each 300,000-gal tank was sampled and the approximate liquid waste composition for that sampling event was determined (Palmer et al. 1998). Tables 2-1 and 2-2 provide the approximate chemical and radionuclide concentrations determined from the 1998 sampling event. The makeup and volumes of the tanks have changed since 1998 (see Figure 2-7 and Section 2.3).

Each 300,000-gal tank has a different waste storage history that has impacted or may impact the removal of the remaining waste. A brief summary of each tank compiled from information contained in Palmer et al. (1998) is provided below:

- WM-180 was put in service in 1954 and stored non-SBW from reprocessing aluminum-clad SNF. The non-SBW in the tank was calcined in 1966 and 1967. The tank has been used only for storing SBW waste since 1972. WM-180 and -181 are the two oldest tanks at the tank farm.

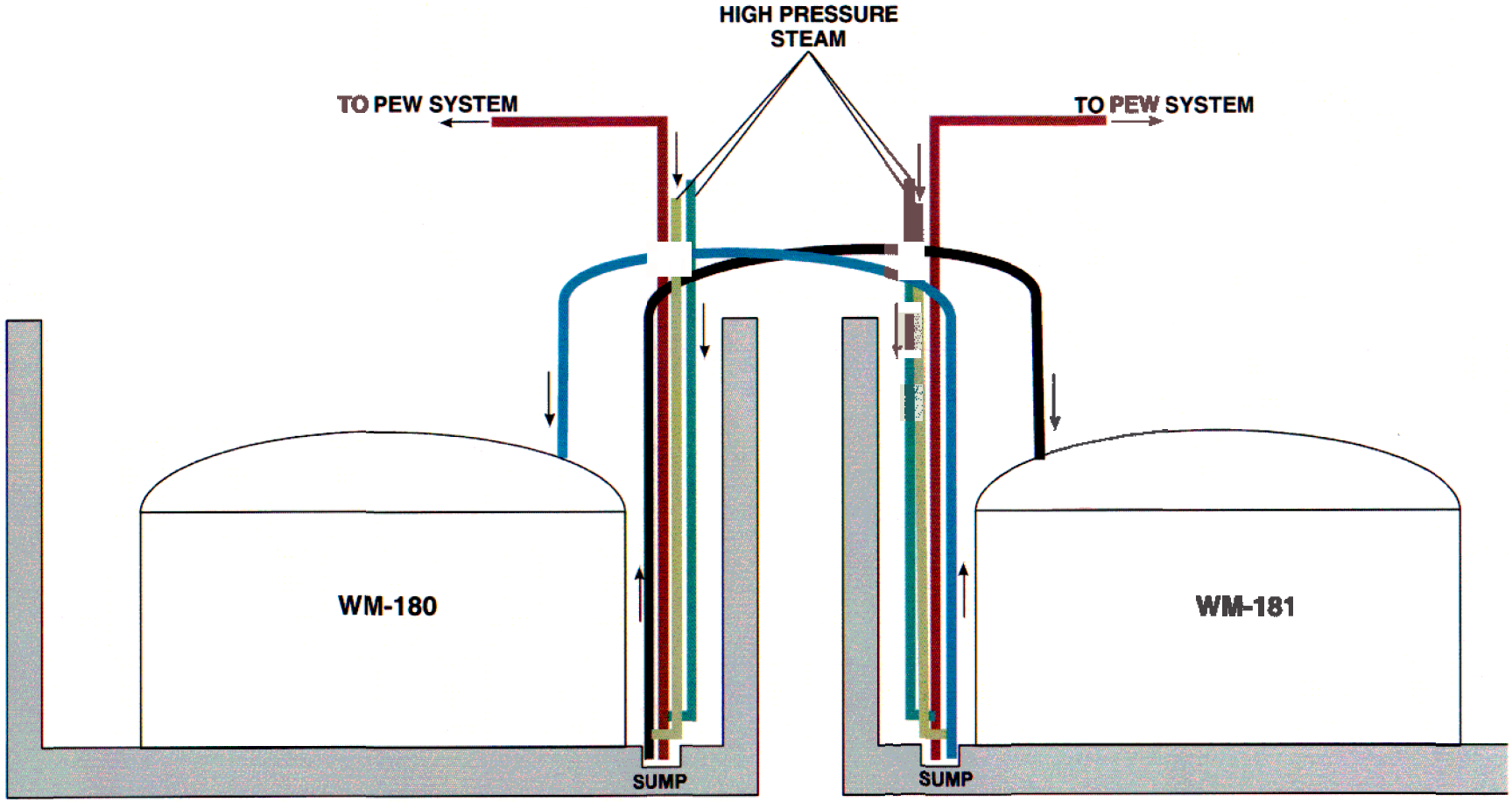

Figure 2-12. Schematic of tank vault sumps for WM-180 and WM-181. (Sumps can also be jetted to the PEW system.)

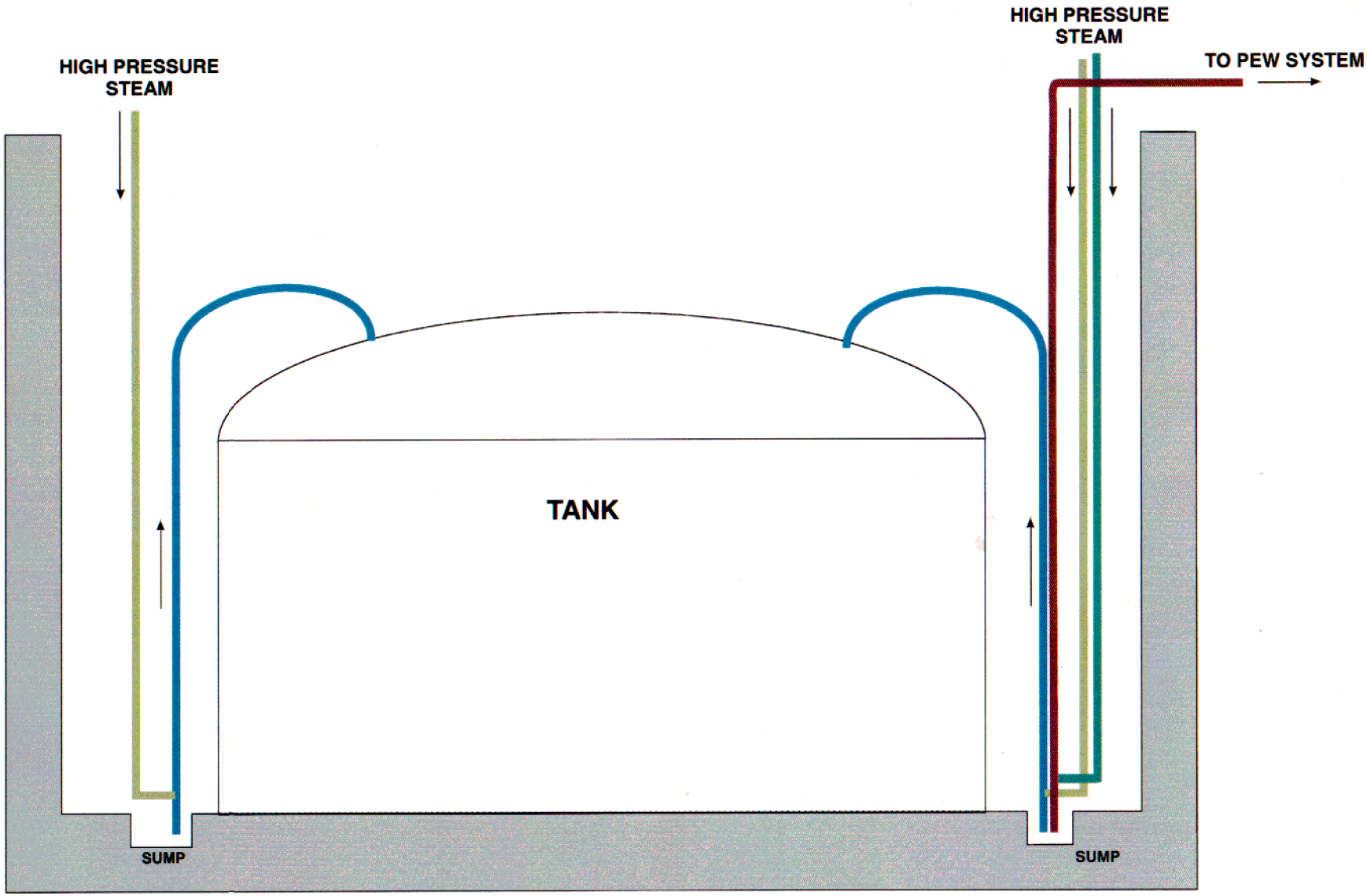

Figure 2-13. Schematic of tank vault sumps for tanks WM-182 through WM-186.

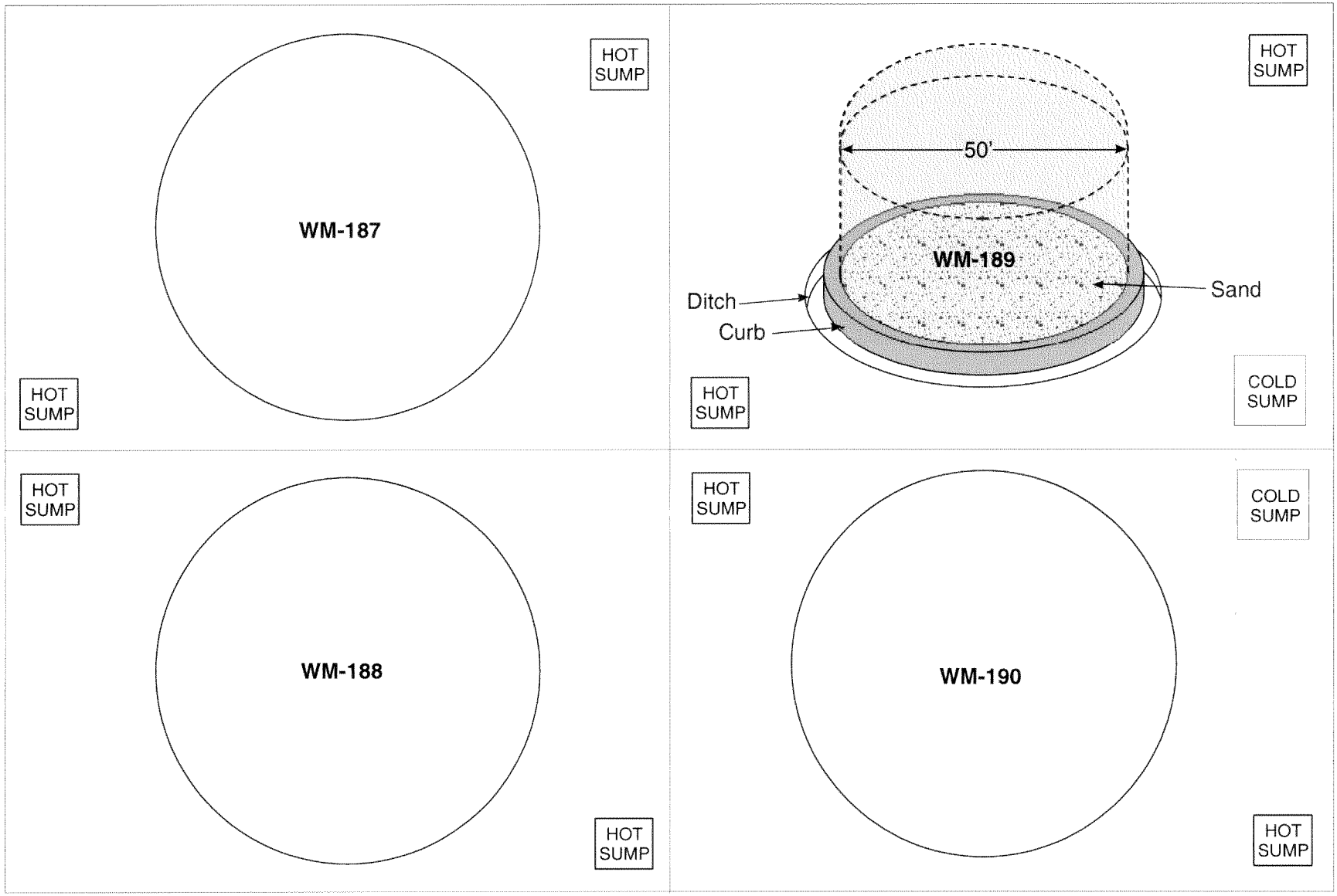

Figure 2-14. Schematic of tank vault sumps for tanks WM-187 through WM-190.

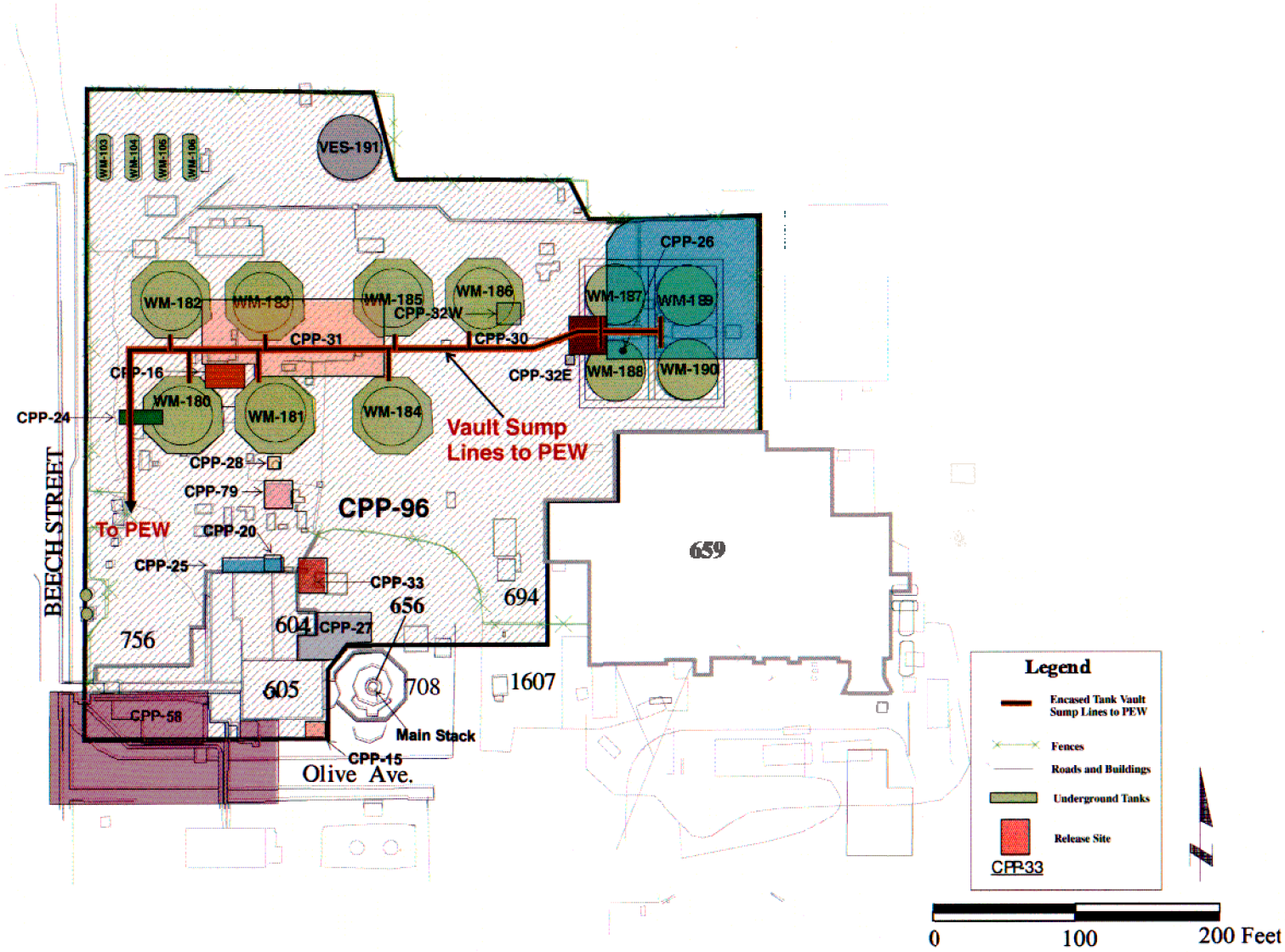

Figure 2-15. Schematic of tank vault sump lines to the centralized tank farm PEW line.

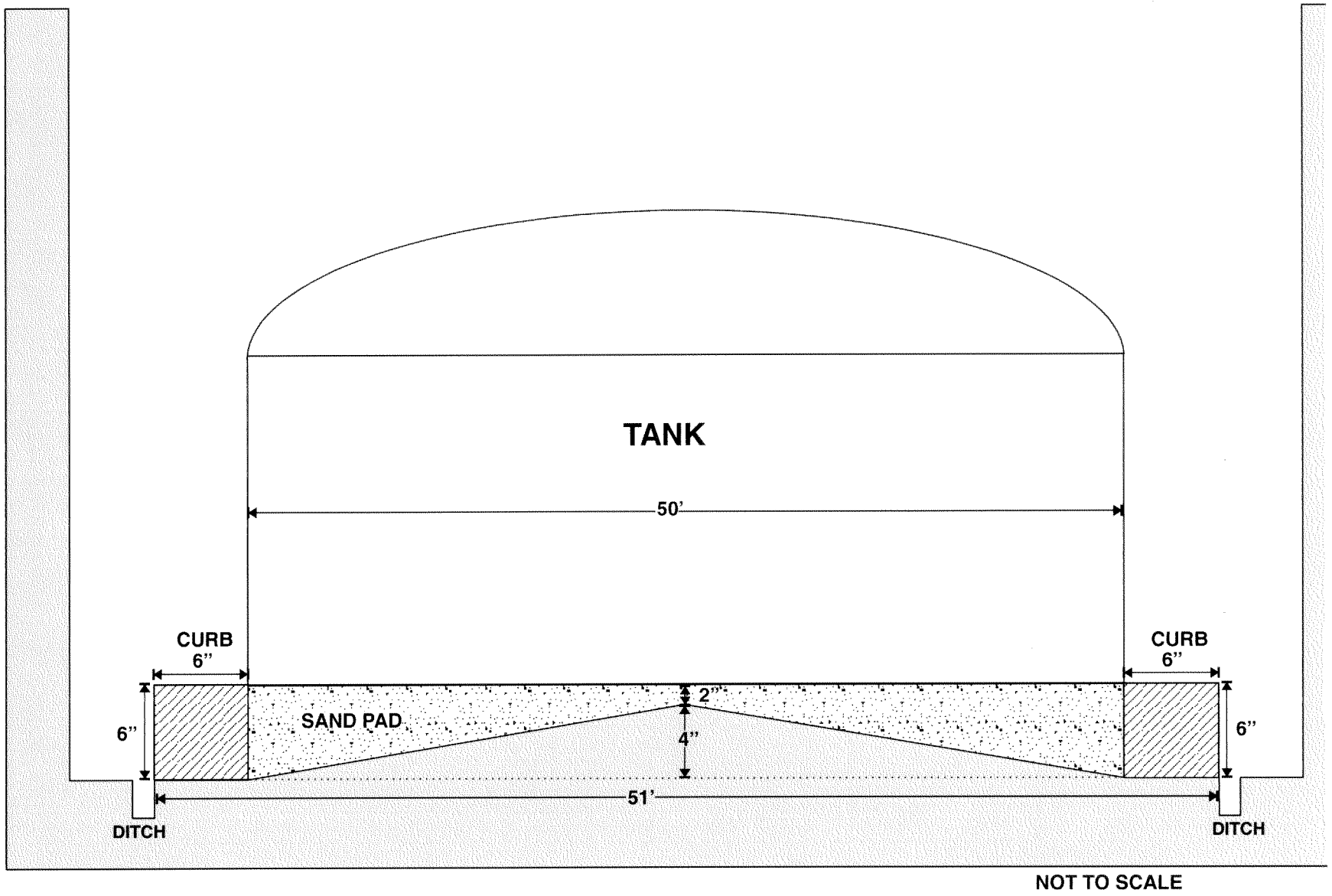

Figure 2-16. Schematic of tank vault with sand pad to cushion the tank bottom, for tanks WM-182 through WM-190. (Not to scale)

Table 2-1. Estimated chemical properties and concentrations in 300,000-gal tanks (from Palmer et al. 1998).

Analyte or Constituent	Unit	WM-180	WM-181	WM-182	WM-183	WM-184	WM-185	WM-186	WM-187	WM-188	WM-189	WM-190
Density	g/mL	1.28	1.16	1.23	1.24	1.27	1.28	1.18	1.16	1.32	1.31	NR[a]
Acid [H^+]	M	1.20	1.89	0.85	2.03	0.45	1.61	1.57	1.98	2.79	2.62	0.02
Nitrate	g/L	298.65	239.98	264.16	342.30	301.99	328.03	190.99	208.97	3.82	401.20	1.24
Aluminum	g/L	17.81	6.21	33.99	17.54	22.93	19.43	9.98	14.57	23.47	28.06	NR
Boron	g/L	0.12	0.17	0.10	0.15	0.08	0.19	0.23	0.14	0.42	0.29	NR
Cadmium	g/L	0.09	0.62	0.023	0.17	0.02	0.22	0.20	0.58	1.07	0.67	NR
Calcium	g/L	1.44	1.84	NR	1.76	0.48	2.85	2.65	1.72	6.25	3.85	NR
Chloride	g/L	1.16	0.57	0.037	0.41	1.61	1.12	0.75	0.08	0.55	0.78	0.01
Chromium	g/L	0.21	0.16	0.05	0.88	0.10	0.26	NR	0.10	0.68	0.31	NR
Fluoride	g/L	0.08	1.79	1.60	1.06	0.80	3.19	0.80	4.41	6.04	6.65	0.13
Iron	g/L	1.06	0.73	1.17	3.41	1.17	1.23	1.06	1.12	3.13	1.95	NR
Lead	g/L	0.31	0.23	NR	0.33	0.25	0.21	NR	NR	0.25	NR	NR
Manganese	g/L	NR	0.77	NR	0.77	0.49	1.10	NR	NR	NR	NR	NR
Mercury	g/L	0.21	0.10	NR	0.56	0.32	0.82	NR	0.16	1.56	0.72	NR
Molybdenum	g/L	NR	0.05	NR	0.07	0.05	0.05	NR	NR	NR	NR	NR
Nickel	g/L	0.10	0.08	NR	0.43	0.08	0.09	NR	NR	0.33	NR	NR
Phosphate	g/L	NR	0.57	NR	NR	2.37	0.28	NR	NR	0.04	NR	NR
Potassium	g/L	7.43	5.87	0.12	3.91	5.47	7.82	6.65	0.78	5.87	5.87	NR
Sodium	g/L	48.51	21.84	0.46	18.62	48.51	33.80	23.22	4.14	17.93	26.21	NR
Sulfate	g/L	3.27	2.40	2.79	6.63	7.20	4.32	3.36	1.06	3.55	2.98	NR
Zirconium	g/L	<0.11	0.46	1.00	<0.15	NR	0.91	NR	2.19	2.46	2.92	NR

a. NR = not reported.

Table 2-2. Estimated radionuclide concentrations (Ci/L) in 300,000-gal tanks (Palmer et al. 1998).

Radionuclide	WM-180	WM-181	WM-182	WM-183	WM-184	WM-185	WM-186	WM-187	WM-188	WM-189	WM-190
Am-241	5.59E-04	2.08E-04	5.02E-04	7.48E-04	2.20E-04	5.59E-04	2.10E-04	4.58E-04	1.42E-03	9.14E-04	NR[a]
Ce-144	NR	1.80E-06	2.01E-05	9.26E-07	NR	1.81E-06	1.11E-06	NR	NR	NR	4.52E-11
Co-60	NR	2.61E-04	1.22E-04	1.45E-04	NR	3.79E-05	5.02E-05	4.59E-05	3.52E-04	1.10E-04	NR
Cs-134	9.03E-04	2.33E-04	2.22E-03	3.43E-04	1.66E-06	1.16E-04	1.16E-04	1.72E-04	1.23E-03	5.40E-04	9.80E-07
Cs-137	2.85E-02	2.94E-02	5.67E-01	2.28E-01	2.02E-02	1.08E-01	3.25E-02	7.40E-02	3.74E-01	1.61E-01	1.06E-02
Eu-154	5.59E-05	2.99E-04	4.44E-03	9.26E-04	NR	2.48E-04	1.38E-04	3.66E-04	1.83E-03	7.30E-04	2.94E-05
Eu-155	NR	9.49E-05	1.14E-03	4.29E.04	NR	NR	NR	1.04E-04	6.36E-04	1.30E-04	4.08E-06
H-3	2.35E-05	2.11E-05	7.76E-04	4.82E-04	NR	3.58E-05	NR	NR	NR	NR	NR
I-129	<1.4E-08	<3.3E-07	NR	<1.2E-05	5.72E-06	<3.9E-05	NR	NR	NR	NR	NR
Ni-63	2.67E-05	6.22E-05	NR	NR	NR	NR	NR	NR	NR	NR	NR
Np-237	4.34E-07	1.93E-07	2.16E-06	7.72E-07	4.60E-07	1.44E-05	2.90E-07	5.67E-07	1.61E-06	1.11E-05	NR
Pu-238	3.47E-04	6.15E-04	2.57E-03	6.59E-04	6.59E-04	8.39E-04	2.32E-04	1.99E-03	3.77E-03	2.82E-03	NR
Pu-239	5.65E-05	1.30E-05	2.85E-04	2.40E-04	8.30E-05	7.52E-05	3.99E-05	1.04E-05	2.39E-0	6.62E-05	NR
Pu-240	1.69E-05	3.65E-06	1.64E-05	1.88E-05	3.40E-05	2.05E-05	9.86E-06	2.34E-06	2.11E-05	1.75E-05	NR
Pu-241	3.18E-04	2.75E-04	6.10E-04	5.61E-04	4.47E-04	9.08E-04	1.75E-04	8.69E-04	1.90E-03	1.63E-03	NR
Pu-242	1.27E-08	8.63E-09	1.94E-08	5.53E-08	1.00E-08	2.44E-08	4.17E-09	5.93E-09	6.05E-08	2.43E-08	NR
Ru-106	NR	5.58E-06	2.81E-05	NR	NR	1.67E-06	2.12E-06	NR	NR	NR	NR
Sb-125	NR	8.96E-05	NR	NR	NR	NR	3.09E-05	NR	NR	NR	NR
Sr-90	2.30E-02	2.82E-02	5.51E-01	1.75E-01	1.56E-02	9.59E-02	3.03E-02	NR	2.84E-01	NR	NR
Tc-99	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
U-234	5.61E-07	8.53E-07	1.98E-06	6.28E-07	8.23E-07	1.31E-06	9.77E-07	3.16E-08	6.39E-07	9.85E-07	NR
U-235	1.54E-08	2.14E-08	5.73E-08	2.65E-08	2.26E-08	2.74E-08	2.27E-08	7.11E-10	2.59E-08	2.07E-08	NR
U-236	7.36E-09	7.56E-08	2.13E-07	2.57E-08	1.43E-08	6.09E-08	5.85E-08	3.18E-09	2.97E-08	4.77E-08	NR
U-238	9.37E-09	2.11E-08	1.08E-09	3.00E-08	9.16E-09	2.47E-08	5.15E-08	2.08E-12	2.77E-08	1.80E-08	NR

a. NR = not reported.

- WM-181 became operational in 1954 and was used as a service waste diversion tank until 1975. Since then, the tank has been used to store SBW. This tank has never been used to store first-cycle raffinate liquid waste (non-SBW).

- WM-182 became operational in 1956 to store non-SBW from reprocessing aluminum- and zirconium-clad SNF.

- WM-183 became operational in 1958 and was originally used to store non-SBW from reprocessing aluminum- and stainless-steel-clad SNF, high-fluoride decontamination solutions, and the PEW evaporator and evaporator bottoms from the WCF. Of all the tanks, WM-183 has contained the greatest variety of waste. The radioactive non-SBW was transferred from the tank in 1981, after which the tank was filled with SBW.

- WM-184 became operational in 1958 and has contained only SBW composed of PEW evaporator bottoms. It has never contained first-cycle raffinate HLW (non-SBW).

- WM-185 became operational in 1959 and has stored non-SBW from aluminum and zirconium fuel reprocessing as well as high-fluoride decontamination waste and PEW evaporator bottoms. After it is emptied, the tank is expected to be used as a spare tank for emergency waste storage (LMITCO 1998; DOE-ID 1998a).

- WM-186 was put into service in 1962 and contained non-SBW from reprocessing aluminum-clad SNF until 1967, when the waste was transferred out of the tank.

- WM-187 was put into service in 1959 and stored non-SBW from reprocessing of aluminum- and zirconium-clad SNF, high-fluoride decontamination waste, and PEW evaporator bottoms.

- WM-188 became operational in 1963 and has contained non-SBW from zirconium fuel reprocessing as well as high-fluoride decontamination waste and PEW evaporator bottoms. Subsequently, this tank now contains SBW.

- WM-189 became operational in 1964 and contained non-SBW from reprocessing zirconium-clad SNF and waste from decontamination and bed dissolutions at the WCF and NWCF until 1996. Subsequently, this tank now contains SBW.

- WM-190 was never placed in service after it was constructed in 1964, but it was retained as the designated spare tank for use in emergencies. It contains about 500 gal of liquid waste (see Figure 2-7) remaining from approximately 7,000 gal of accumulated meteoric (i.e., rainwater and snowmelt) vault sump water and liquid waste that leaked through closed valves and collected in the tank over time. The meteoric liquid was pumped from the tank in 1982 using a sump pump that emptied the tank as much as possible without personnel entry, leaving no more than 500 gal.

A summary of the fuel processed and tank usage history is provided in Table 2-3.

2.4.3 30,000-gal Tanks

The four inactive 30,000-gal tanks (VES-WM-103 through -106) were constructed in 1954 and are stainless-steel belowground tanks on reinforced-concrete pads. Unlike the 300,000-gal tanks, the 30,000-gal tanks have no vaults. These tanks were normally empty, because they have no containment vaults. From 1957 to 1965, these tanks were used to temporarily store specific processing waste, such as zirconium and stainless-steel waste from the CPP-601 E cell, until compatibility of the waste with that in the 300,000-gal tanks was determined. Then the waste was transferred to one of the 300,000-gal tanks.

Table 2-3. Types of fuel dissolution performed at INTEC (based on Wagner 1999).

Dissolution	Process Description	Facility	Campaign Dates	Comments
Aluminum (batch)	Aluminum-based fuels were dissolved in a nitric acid solution in the presence of a mercuric nitrate catalyst. Hexone was used as the uranium solvent for first-, second-, and third-cycle extraction.	CPP-601	1953–71	The equipment was removed in 1984.
Aluminum (continuous)	Aluminum-based fuels were dissolved in a nitric acid solution in the presence of a mercuric nitrate catalyst. Tributyl phosphate (TBP) was used as the solvent for first-cycle extraction, and hexone was used for second and third cycles.	CPP-601	1957–86	Startup of aluminum-based fuel reprocessing campaigns began in 1957, and the campaigns occurred intermittently, with the last successful campaign starting in 1986 and ending in 1987. In 1992, the fuel reprocessing system was undergoing "startup operations" when the decision was made by DOE to terminate all fuel reprocessing.
Zirconium	Zirconium-based fuels were dissolved in hydrofluoric acid. TBP was used for first-cycle extraction, and hexone was used for second and third cycles.	CPP-601	1957–81	The system was refurbished in 1986 but not used. To reduce the waste volume, the aluminum and zirconium dissolution processes were run together to eliminate the step of adding cold aluminum nitrate to complex fluoride.
Fluorinel (fluorinel dissolution process [FDP])	Newer types of zirconium-based fuels were dissolved in hydrofluoric acid.	CPP-666	1986–88	Before the termination of reprocessing, FDP was intended to be the major method of dissolution at INTEC. Cadmium nitrate was used as a nuclear poison to prevent criticality.
Stainless steel (Submarine Intermediate Reactor)	Stainless-steel fuels were dissolved in sulphuric and nitric acid.	CPP-601	1959–65	None.
Stainless steel (electrical dissolution process)	Stainless-steel fuels were dissolved in nitric acid while a direct electrical current passed through fuel.	CPP-640	1973–81	The run was terminated because of equipment failure.
ROVER	Graphite fuels were first burned in oxygen to reduce the graphite. The uranium materials were dissolved in hydrofluoric acid.	CPP-640	1965–84	Uranium-bearing material recovery was completed at the facility in 1998.
Custom	Other fuels, such as cermet-type, were dissolved in specially designed equipment.	CPP-627	1965–91	The final run was terminated because of equipment damage.

The tanks are about 11.5 ft in diameter, about 38 ft long, and covered with compacted gravel. The 30,000-gal tanks were emptied to their heels and taken out of service in 1983. Raw water was added to the tanks in 1990 to provide enough solution to sample for RCRA characteristics and radionuclides. The tanks were tested for pH, metals, and organic compounds. The pH results ranged from 3.4 to 7.9 (WINCO 1990a, 1990b, 1990c, 1990d), the RCRA characteristics were determined to be nonhazardous,[g] and the radiation readings ranged from 6 to 35 mR/hr.[h, i] As part of the closure, the lines have been flushed and the tanks sampled.

2.4.4 Tank Farm Piping and Secondary Containment

The primary piping for transferring waste at the tank farm was constructed with stainless steel to withstand the corrosive nature of the waste. Four principal types of secondary containment (encasement) surrounding the primary piping were used historically. The four types of encasement were as follows:

1. Split clay tile
2. Split steel
3. Stainless-steel-lined concrete troughs
4. Stainless-steel pipe within a pipe.

Each encasement type is described below in further detail as well as where and when the style of piping was used and the configuration's strengths and weaknesses. Any liquid waste that leaked into the encasement system drained to the respective valve box sump. Most valve boxes had drain lines directing the sump liquid to a tank vault sump or to a tank (see Section 2.4.5). However, to be RCRA-compliant, valve box sumps draining to tank vault sumps (not RCRA-compliant) had to be plugged. Also, some valve boxes have always had to be drained manually. Valve boxes and tank vaults have radiation and level detection instrumentation and sump level alarms (tank vaults and valve boxes) to detect the presence of liquid. If a line is suspected of leaking (regardless of the release mechanism), the line is immediately taken out of service and is not reused until it has been repaired.

2.4.4.1 Split Clay-Tile Encasement. As a part of the original INTEC liquid waste system installed between 1951 and 1952, stainless-steel lines using split clay-tile encasement were installed to transfer waste solutions. Waste solutions generated in the CPP-601 process building were transferred through five, 3-in., stainless-steel pipelines to the tanks in the CPP-604 vault (PY-2401Y, PU-2297Y, WB-1009C, WD-1004C, and WC-1019C, all of which are abandoned). Each line was supported inside separate 6-in. split-tile encasements, which were enclosed in a concrete envelope, as shown in Figure 2-17. Concrete sampling boxes were provided at 50-ft intervals along the encasements for leak detection. Each of the pipes and the encasement were sloped and terminated in a sampling box located near the ceiling inside the CPP-604 tank room. Any leakage from the pipelines was designed to flow through the tile encasements to the respective sample box for sampling. Overflow lines from the sample boxes directed flow to the level-alarmed collection sumps in the tank room cells. No leaks were detected between 1951 and 1974 in the five lines.

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g. Interdepartmental correspondence from A. J. Matule to D. C. Machovec, "Solids Sampling of WM-103 through -106," AJM-20-90, Westinghouse Idaho Nuclear Company, Inc., September 26, 1990.

h. Interdepartmental correspondence from D. C. Machovec to A. J. Matule, "WM-103/106 Solids Sample," DCM-08-90, Westinghouse Idaho Nuclear Company, Inc., August 28, 1990.

i. Interdepartmental e-mail from D. C. Machovec to P. A. Tucker, "Results of Sampling of the 30,000-gal Tanks," Lockheed Martin Idaho Technologies Company, April 26, 1999.

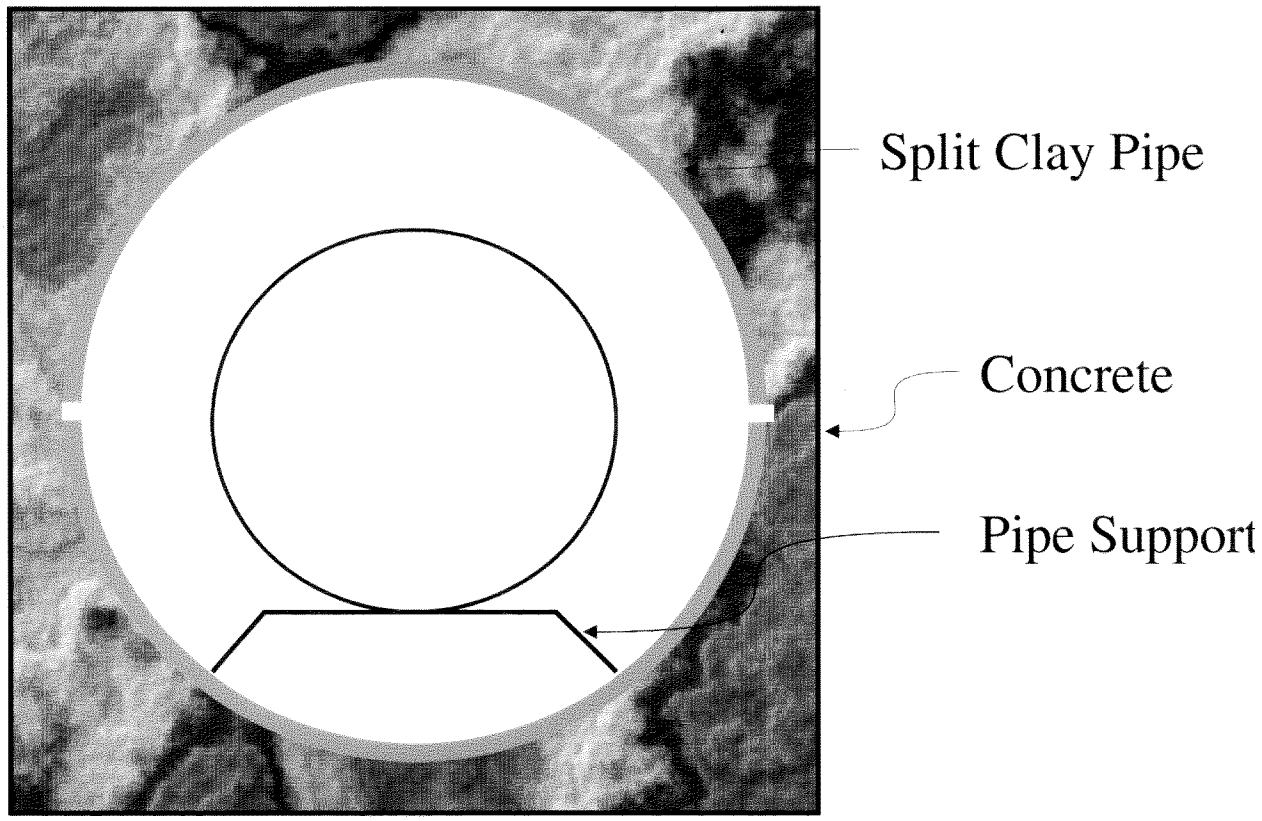


Figure 2-17. Design of encasement with split clay tile.

Five additional pipelines were also installed to transfer waste solutions from the CPP-604 tank room to WM-180 and -181 (from WM-100 to -180, PWM-10019Y; from WM-101 to -180, PWM-20028Y; from WM-102 to -180, PWM-3019Y; and two lines from WL-101 to WM-181, PWA-1013 and PWA-1014). Each of these lines was included in the leak-detection system with similar split-tile encasements sloped downward from WM-180 and -181 to sample boxes on the outside of the north wall of the CPP-604 tank room. These sample boxes also had overflow lines that drained to the CPP-604 tank room floor sumps. Also included in the design of the three waste lines to WM-180 were provisions for tie-ins with future storage tank additions (PWM-2011Y, PWM-1024Y, and 3"PWM-10019Y). This consisted of a vertical loop to a point 2 ft abovegrade with a flanged valve and a flanged tee connection at the top of the loop. These pipe loops were also separately encased in split tile between lower junction boxes 38.7 ft belowgrade and an upper diversion valve box (A-3A, A-3B, and A-3C) at the surface. Leakage from the pipeline or the loop, if any occurred, would flow into the lower junction box and flow from there through the encasement into the respective sample boxes. The two waste transfer lines from WL-101 to WM-181 were not originally provided with the future tie-in provisions. Locations of the waste transfer lines using the split clay pipe encasement are shown in Figure 2-18.

The design of the split clay-tile encasement was not completely compatible with the waste it could contact. The clay pipe itself was compatible with the waste, but leaking acidic waste could eat through the mortar used to attach and seal sections of the split-tile piping, compromising the secondary containment. In addition, the rigid nature of the encasement system may have made it susceptible to cracking due to soil settling and compaction. Most of the tile-encased pipes have been replaced or abandoned.

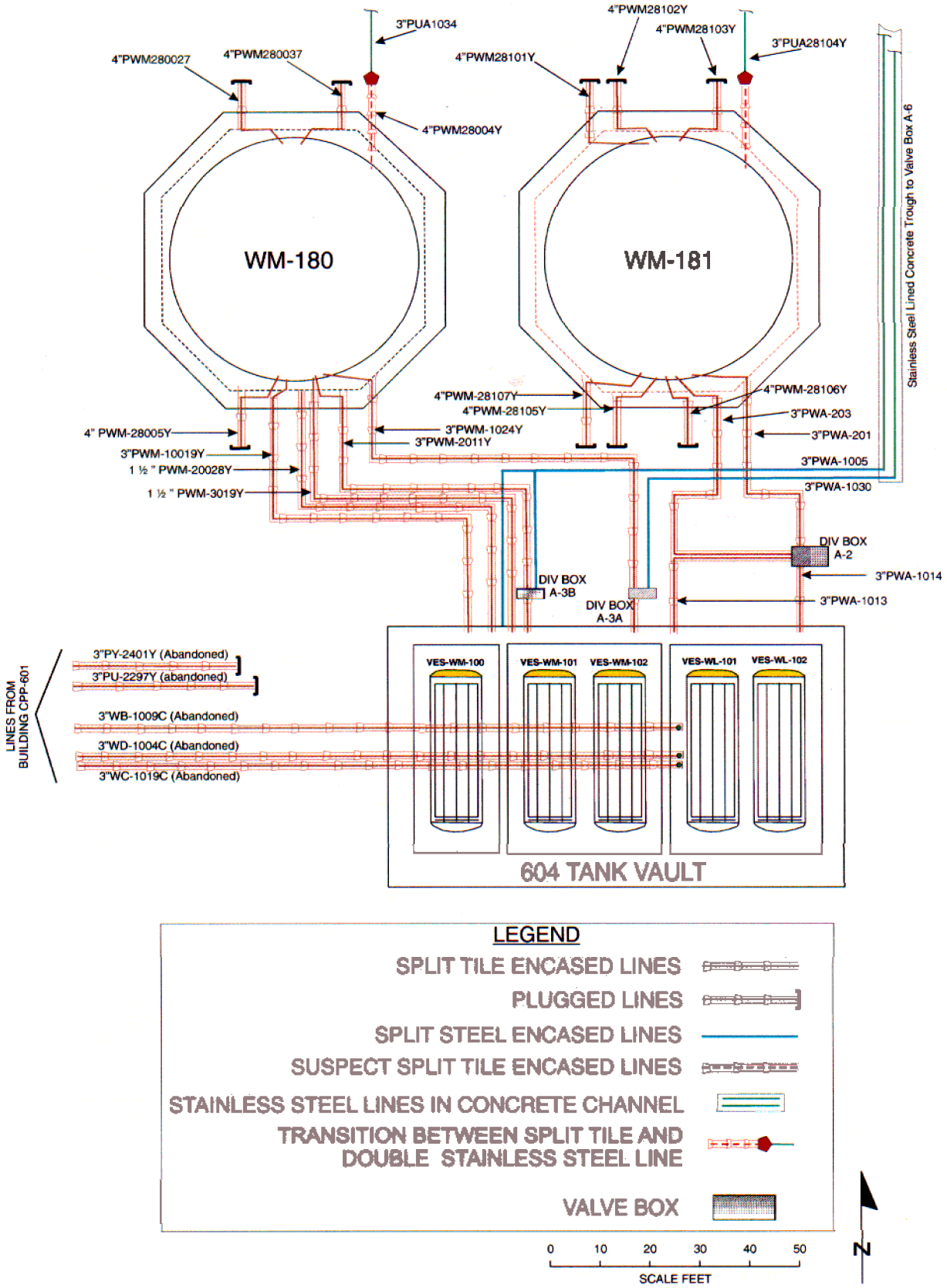


Figure 2-18. Locations of the waste transfer lines using split clay pipe and split steel encasement.

Figure 2-18 shows two "suspect" split-tile-encased lines, one on WM-180 (4"PWM28004Y) and the other on WM-181 (4"PWM28104Y). These are the only split-tile-encased lines that are operable in the tank farm. These lines are administratively controlled such that they can only be used under special circumstances using strict procedures. No process knowledge or evidence to date indicates these lines have ever leaked. They are labeled "suspect" only because they are encased in the split clay tile, but, if the clay pipe were to ever leak, an acidic waste could damage the mortar of the split-tile encasement.

The design of the tank farm is such that leaking liquid is detected by radiation and tank level detection instrumentation. Any leakage from one of these split-tile-encased process lines would flow through the tile encasements to the respective sample box (located near the ceiling inside CPP-604 tank room) for sampling. Overflow lines from the sample boxes directed the flow to the level-alarmed collection sumps in the CPP-604 tank room cells. Sump liquid could be jetted to the appropriate CPP-604 waste tank for subsequent transfer to either the tank farm or the PEW evaporator. Administrative controls require a leaking line be immediately taken out of service and not reused until it has been repaired.

Throughout the operational history of the tank farm, administrative controls and procedures have been in place to ensure the success of each transfer. Assessment of the compatibility of a liquid waste (i.e., acidic, water, etc.) is performed to ensure the appropriate line (i.e., stainless, carbon, single containment, double containment, etc.) is used to transfer the waste liquid. In addition, strict controls exist on the carbon line from CPP-628. There are controls on intertank transfers, i.e., sending and receiving tank volumes are documented before and after each transfer. This ensures transferred liquid reaches the intended receiving tank. In the event the transferred liquid does not reach the intended receiving tank, an inadvertent transfer is determined by checking the volumes of other tanks and then taking appropriate action to correct the situation. Two sets of instruments are in each tank to measure tank volume with a precision of at least ±200 gal. Original instrumentation included a pneumatic air instrument probe. In 1974, additional instrumentation (an electronic radio frequency probe) was added to each tank. Air lift operations and jetting liquid from the sumps, etc., are also directed by administrative controls.

2.4.4.2 Split Steel Encasement. In 1955, a major expansion program was started that included the construction of three new waste storage tanks, WM-182, -183, and -184, along with enlarging existing, and installing new, valve boxes and constructing new pipelines, encasements, and supports from the valve boxes to the new tanks. Two completely different pipe encasement designs were used during this phase of the tank farm expansion. Most of the encasement installed used the stainless-steel-lined concrete trough discussed in the following section. However, approximately 160 ft of waste-transfer piping used the split steel encasement design and was installed from valve boxes A3-A and A3-B to where they connected to the stainless-steel-lined concrete trough (Figure 2-18). This design consisted of (1) a lower trough section of welded stainless steel in which the stainless-steel transfer pipeline was supported and (2) an upper cover section of carbon steel that overlapped and was pinned to the lower stainless-steel trough by No. 10 × 3/8-in.-long, hex-head, tapping screws spaced on 1-ft centers along its length (Figure 2-19). The upper 1/8-in.-thick cover was installed in 10-ft sections (maximum), with ends lapped 2-in. in the direction of flow and painted with two coats of bitumastic paint. The encasement rested on undisturbed soil or compacted soil backfill.

This encasement design was not entirely compatible with the waste it was designed to contain. The carbon-steel upper cover was susceptible to corrosion if it came into contact with the acidic waste solution for extended periods. Failure of the top cover would allow soil to collapse into the lower stainless-steel trough, blocking the designed drainage toward connecting valve boxes.

2.4.4.3 Stainless-Steel-Lined Concrete Troughs. As stated in the previous section, the 1955 tank farm expansion used the stainless-steel-lined concrete trough design encasements for nearly all of the new waste-transfer lines. This design consisted of a pile-supported, reinforced-concrete trough

lined with stainless steel, with sloped drainage to sampling sumps and removable concrete cover plates (Figures 2-20 and 2-21). This secondary containment design has been trouble-free with no known releases.

2.4.4.4 Stainless-Steel Pipe within a Pipe. Starting in 1957, secondary containment for waste-transfer piping was changed to the stainless-steel pipe-within-a-pipe design, which was used during installation of the new intertank transfer-piping system, allowing the tanks in the tank farm to be filled and emptied as necessary. At the completion of the intertank transfer system, waste could be transferred from any tank to any other tank or to the WCF, which was then under construction. The stainless-steel pipe-within-a-pipe design is shown in Figure 2-22.

Very few problems, if any, have been associated with the pipe-within-a-pipe design. The stainless-steel inner and outer material is compatible with the acidic waste solutions.

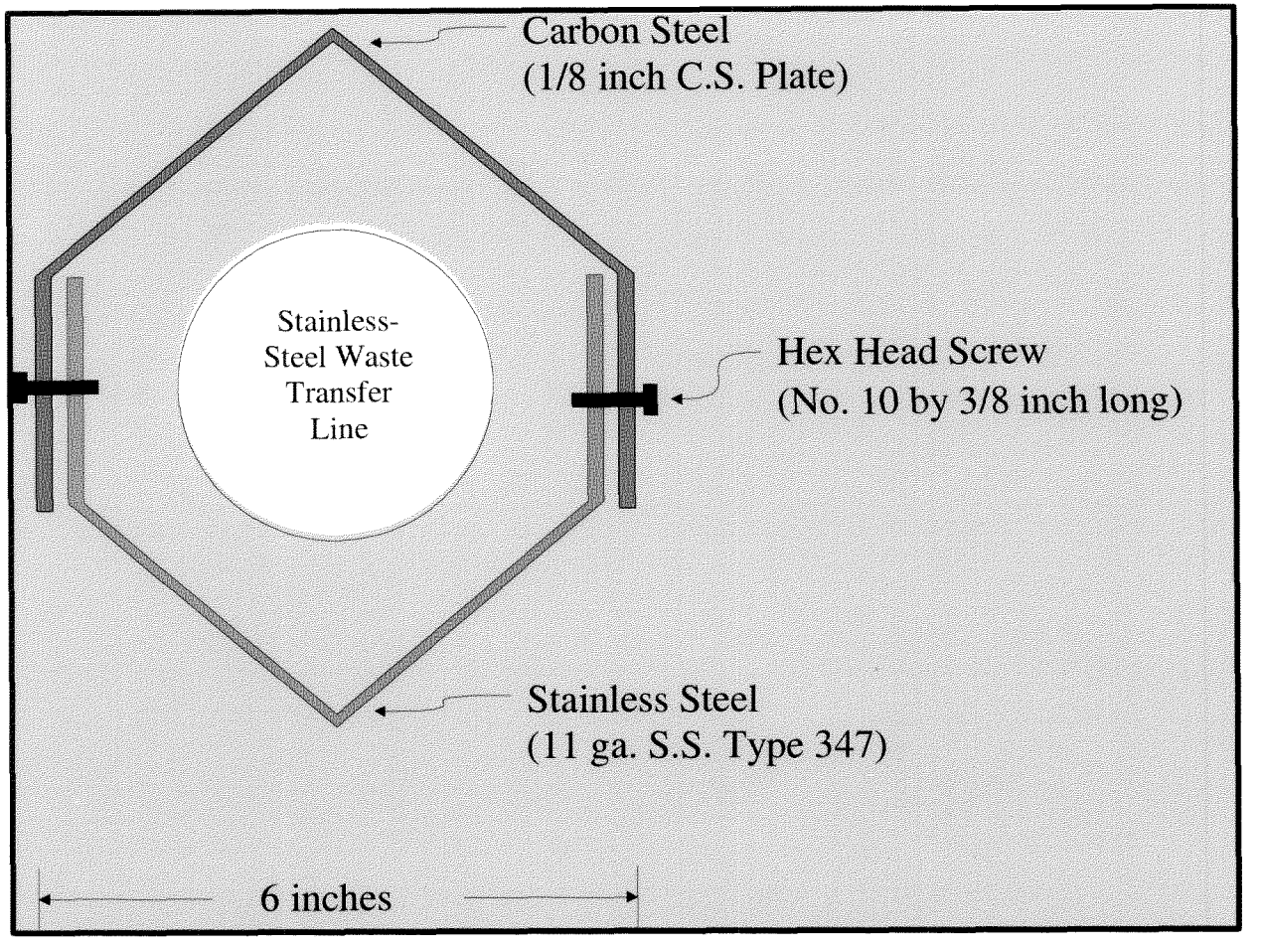


Figure 2-19. Split steel encasement design.

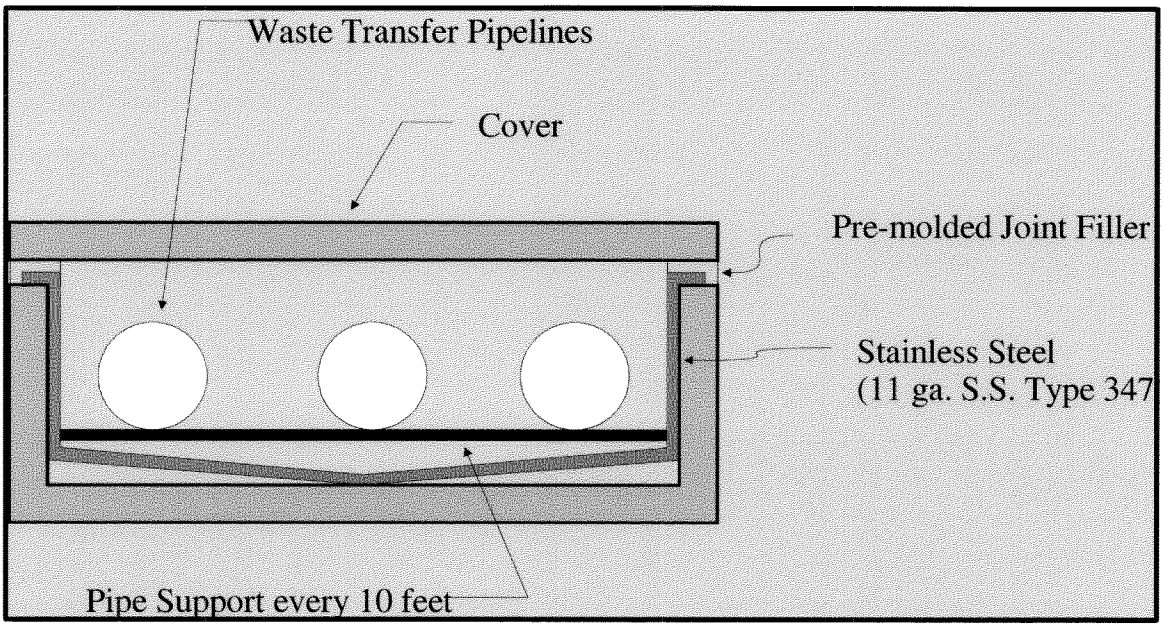


Figure 2-20. Stainless-steel-lined concrete trough encasement design.

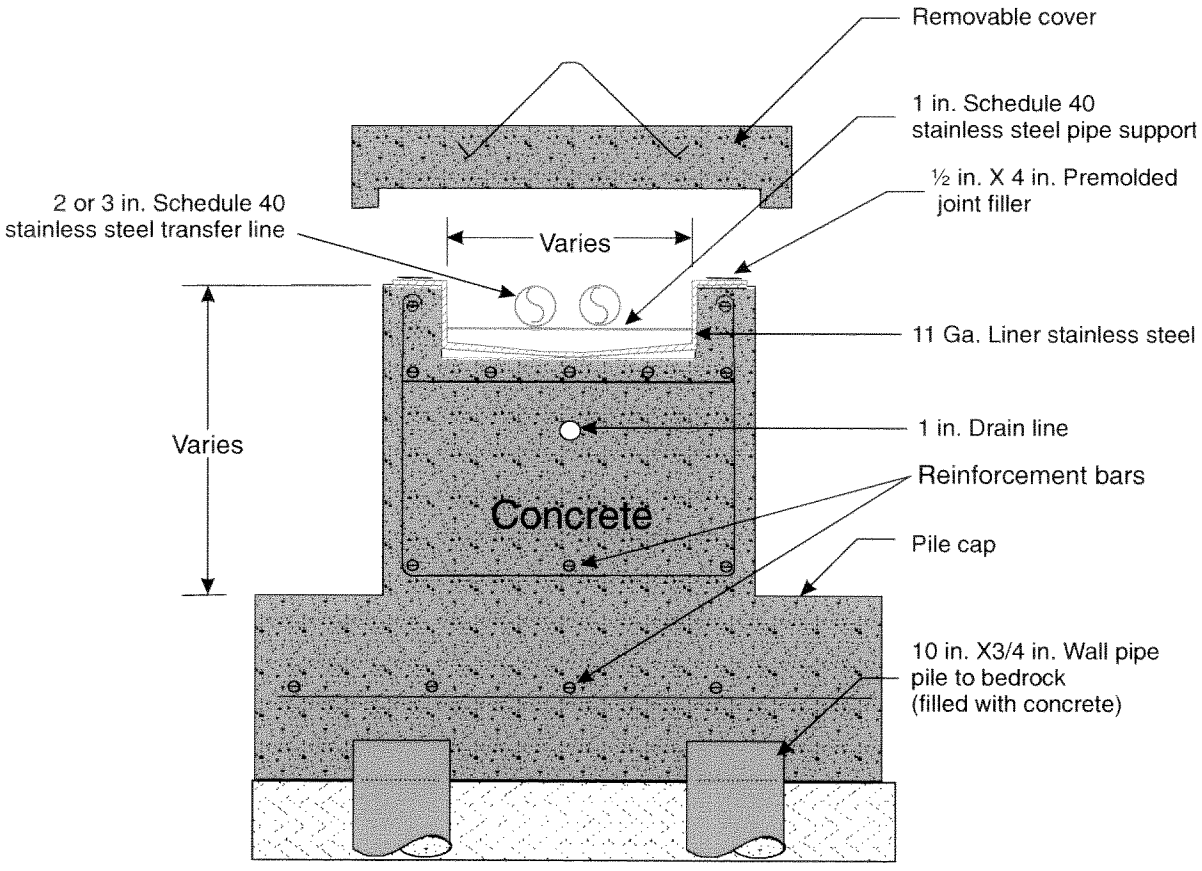
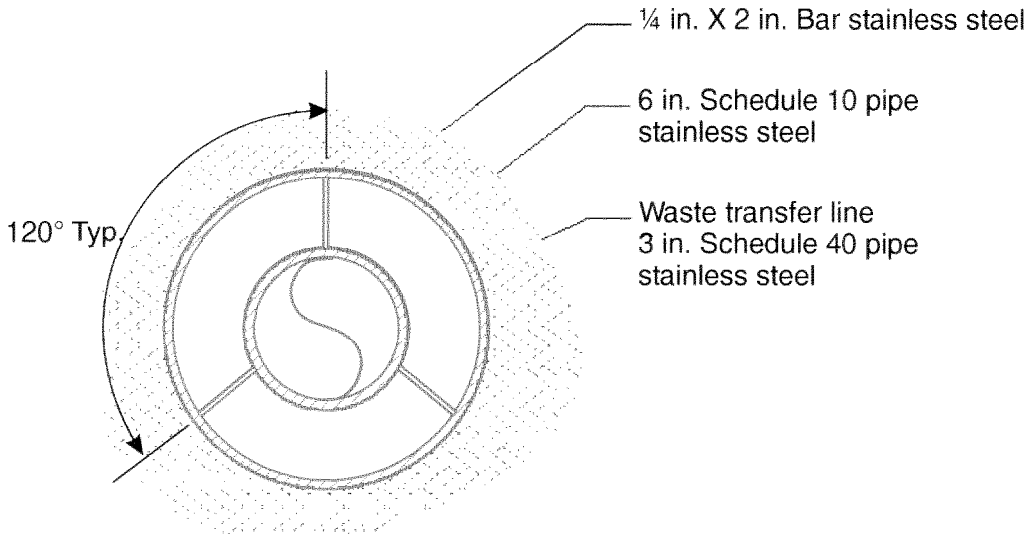


Figure 2-21. Piling and support cap design for the stainless-steel-lined concrete trough encasement design.



Typical buried stainless steel encased pipe

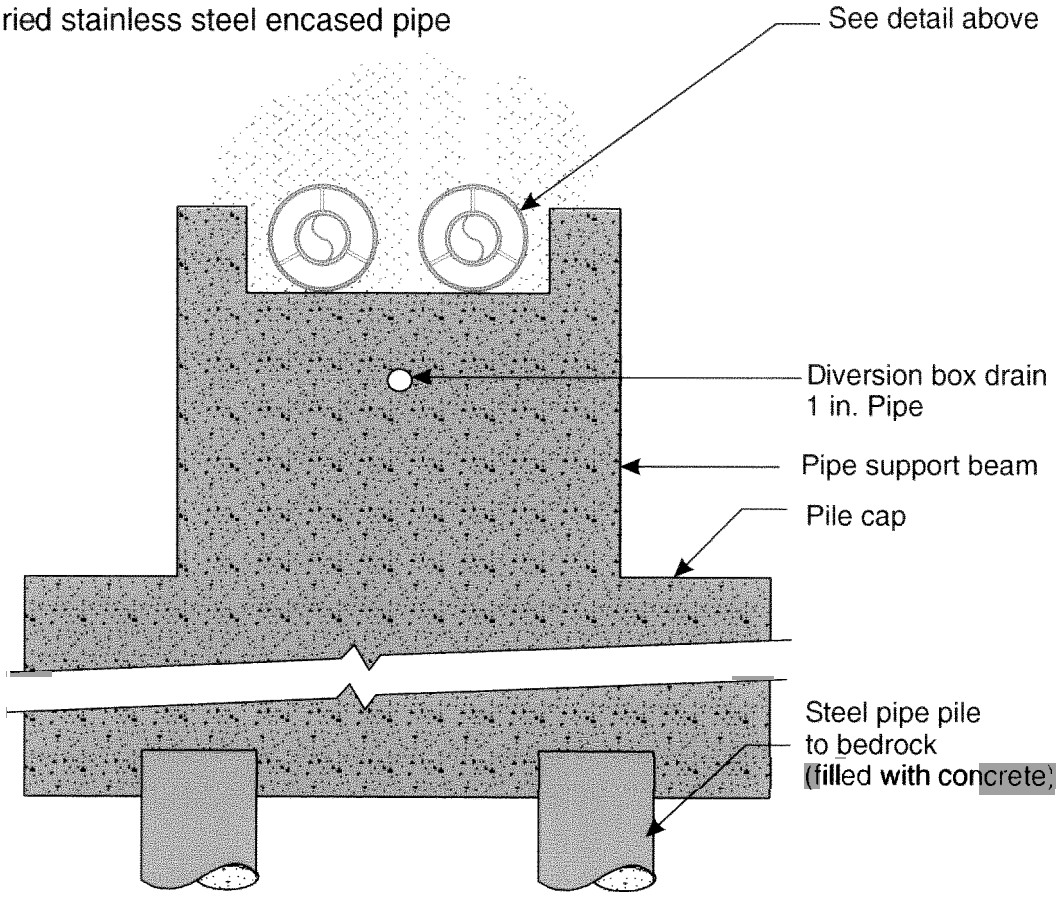


Figure 2-22. Stainless-steel pipe-within-a-pipe encasement design.

2.4.5 Valve Boxes

Initial construction in the tank farm with WM-180 and WM-181 in 1951 consisted of minimal piping, pipe junctions, and interfaces (i.e., valve connections). Over the years, several construction phases modified the tank farm by adding tanks, waste transfer lines, and valve boxes; upgrading transfer line valves; replacing some valve boxes; and removing unused valve boxes.

The valve boxes are located where pipe runs change directions and are constructed to provide protection for pipe joints. They also provide containment for valve leaks and process transfer line leaks, which drain by gravity through the pipe encasements and into the nearest valve box sump. Each valve box is equipped with level alarms, and sump jets for those with drain lines to transfer liquid waste, condensate, or water infiltration to the nearest tank, vault sump (prior to tank farm RCRA compliance upgrades), or directly to the PEW evaporator (with the installation of the C series valve boxes). Until the B series valve boxes were installed, only abovegrade transfer hoses, manual hookups, and temporary steam sources were available to allow liquid removal. Valve boxes without drains had to be checked manually following each transfer routed through that valve box.

There was no standard system for valve box identification in the tank farm other than the A, B, and C series. The number following the letter designation (A, B, or C) was also not always sequential. In general, the A series was installed with the 1954 construction of tanks WM-182 through WM-184. The B series began in 1957 with the construction of WM-185 and WM-186. However, subsequent upgrade projects at the tank farm also used the "B' designation on valve boxes. The C series installation began in 1977.

Each concrete valve box is reinforced and lined with stainless steel. (The interior surfaces of C series valve boxes were painted with an enamel-based paint [Americoat 33]). Bitumastic #50, a material similar to tar thatch, was used as filler around pipe sleeves. The approximate valve box dimensions are 6 ft long, 6 ft wide, and 6.5 ft high with a wall thickness of 0.5 ft. Typically, valve boxes extend approximately 1 ft abovegrade.

The B series valve boxes consolidated some of the process waste line valves, primarily those associated with the tank-filling process waste lines, and served as the main transfer junction boxes for tank farm transfer routes. The B series had a new jet pump design that provided a permanent means for transferring waste. The valve boxes provided the means to transfer process waste with lines running between belowgrade storage tanks and the WCF, and later the NWCF. Each process waste pipeline associated with a storage tank was connected to separate flow control valves. The turning shaft and handle extend abovegrade level for manual manipulation. A protective sleeve surrounding the turning post was extended to grade surface. These valves were located inside the encasement portion of the process piping.

In the early 1970s, several individual buried waste process transfer line valves began to fail (i.e., leaking, sticking open or closed) in the older valve boxes and these were repaired. The repairs required radiation shielding and excavation in soils. As a result of this, the installation of the C series valve boxes was undertaken in 1977. These valve boxes were designed to improve the waste transfer valve system. This included improving valve access for maintenance and attaching drain lines to transfer valve box sump liquid to a centrally located PEW evaporator line. Also, older valves were refurbished, pipes were rerouted to valve boxes, valves were consolidated within the new valve boxes, and some valve boxes were replaced. The improved valve access minimized the need for future excavations, increased protection to workers from contaminated soils, and reduced repair costs.

By 1977, radiation monitors were installed throughout the tank farm. These monitors were installed to detect leaks within valve boxes or other enclosed areas. These monitors were connected to surface-accessible junction boxes and inaccessible conduit duct banks, which routed to the Computer Interface Building (CPP-618).

Around 1989, the radiation monitors installed with the 1977 valve box upgrade were replaced with improved radiation monitors. This replacement provided for more accurate process waste leak detection in enclosed tank farm areas.

With continued use and aging, the tank farm process line valves continued to fail. Valve failure allowed radioactive process waste to leak into associated valve boxes. Some of the valves still required manual replacement/repairs, which entailed manual excavation and worker radiation exposure potential.

Prior to the April 1992 INEEL RCRA "Notice of Noncompliance Consent Order," all tank farm process equipment, including valve boxes, was assessed for RCRA compliance. Only two valve boxes were found to be deficient due to marginal secondary containment. The 1992 HLWTFU project was designed to address process operability and worker radiation exposure concerns. This primarily consisted of cutting and capping the lines encased with split clay tile as directed by the April 1992 INEEL RCRA "Notice of Noncompliance Consent Order," and removing the related valve boxes that no longer served any function. The two noncompliant valve boxes were upgraded to be RCRA-compliant with the mandatory secondary containment (a complete stainless-steel liner). The remainder of the 1992 HLWTFU project consisted of replacing transfer line valves (encased in valve boxes) so that they could be remotely repaired (which reduced worker radiation exposure). Workers could replace the valve cartridge from above using extension tools, thus eliminating the need to excavate down to the valve box.

2.5 Sources of Tank Farm Waste

Although fuel-reprocessing operations produced most of the liquid waste transferred to the tank farm, other facilities also generated waste that was transferred to the tank farm. A historical summary of the fuel reprocessing operations and waste streams stored at the tank farm is provided in the following sections.

2.5.1 Fuel Reprocessing

Reprocessing operations at INTEC took place from 1952 until they were phased out in 1992. These operations used a three-cycle solvent extraction process to recover enriched uranium from SNF. The SNF was dissolved in hydrofluoric or nitric acid to form a uranyl nitrate solution suitable for solvent extraction. The fuel types included aluminum, zirconium, stainless steel, graphite, and custom (see Table 2-3). The fuel dissolution process varied, depending on the type of fuel to be reprocessed. The enriched uranium was then extracted using a three-step solvent-extraction process. The solution remaining (raffinate) after the first extraction cycle was considered non-SBW and was stored in the tank farm. The liquid remaining from the second and third extraction cycles, as well as solutions resulting from decontamination activities, was for the most part stored separately in the tank farm. The waste resulting from decontamination activities is generally referred to as SBW because of the relatively high sodium content (when compared to first-cycle wastes). Although reprocessing operations have ceased, the tank farm continues to receive waste from INTEC plant operations and decontamination activities (see Section 2.3).

2.5.1.1 Fuel Dissolution. The initial step in reprocessing SNF at INTEC was fuel dissolution, which produced a solution of uranyl nitrate for solvent extraction. The different types of fuel dissolution processes, known as "headend" operations, are shown in Table 2-3.

The fuel dissolution processes produced a liquid uranium-bearing product stream for the solvent extraction process. The stream would sometimes be prepared as a "feed" by (1) clarification by centrifuge to remove particulates, (2) adjustment of the chemical composition by adding aluminum nitrate to drive the U-235 to the organic phase from the aqueous feed stream, or (3) suppression of emulsions by adding gelatin. The gases, xenon and krypton, were completely released during fuel dissolution and were recovered commensurate with the economic demand (WINCO 1986a).

2.5.1.2 Fuel Extraction. In the first-cycle extraction process, uranium was extracted from the uranyl nitrate solution into a solution of TBP and dodecane. The aqueous raffinate stream from this extraction, which included the fission products, was sent to the tank farm waste tanks unless the uranium concentration remained high enough for further extraction (WINCO 1986b).

The second- and third-cycle extraction processes used the hexone extraction process to purify the uranium product from the first-cycle extraction. The process used the solvent methyl isobutyl ketone (hexone) to separate the uranium from residual fission products and transuranic (TRU) elements such as neptunium and plutonium. The waste material containing the transuranics and fission products was generally evaporated to reduce its volume before being sent to the tank farm prior to calcination (WINCO 1986b).

2.5.1.2.1 First-Cycle Raffinates—All first-cycle raffinates were acidic, with a hydrogen-ion concentration between 1 and 3 *M*. Radionuclides in the first-cycle raffinates produced a typical radioactivity level in the stored wastes from 5 to 40 Ci/gal (INEEL 1998). The raffinates from zirconium dissolution and co-processed zirconium and aluminum dissolution were fluoride-bearing wastes. The first-cycle raffinates from the dissolution of aluminum and stainless-steel fuel were non-fluoride-bearing (WINCO 1986b).

The chemical and radiochemical composition of the wastes and the amount of heat generated vary with the type of fuel being processed, decay time before processing, and fuel burnup. Chemicals in concentrations up to 4 *M* and large quantities of fission products are present. The major chemicals present in the non-fluoride waste are aluminum and nitrate; the major chemicals present in the fluoride waste are aluminum, zirconium, fluoride, and nitrate (INEEL 1998).

The primary transfer route for first-cycle waste from the process areas to the tank farm was via two 3-in. lines (3"-PUA-2297Y, which was replaced in 1982 by 2"-PUAR-104853, and 3"-PUA-2401Y, which was also replaced in 1982 by 2"-PUAR-104854) to the surge transfer tank, WM-178, for possible transfer to eight of the eleven 300,000-gal storage tanks. (After 1967, tanks WM-181 and -184 were reserved exclusively for SBW, and WM-190 was designated the emergency spare.) Because the airlift for WM-178 would entrain moisture droplets into the off-gas filter system, the raffinate siphon system was installed in the mid 1980s, which allowed WM-178 to be bypassed. However, the gravity-vacuum system required the addition of wastewater to restart the system when the siphon would shut down. In 1986, the siphon system was replaced by steam jets, which still bypassed WM-178. In 1992, the WM-178 tank lines were capped, and the tank was abandoned in place because of a lack of secondary containment.

The first-cycle extraction waste streams, relatively high in radioactivity, were analyzed for uranium content. (During the early years of extraction, the waste was then evaporated, if possible, to reduce volume. However, the evaporation step was subsequently eliminated to avoid problems associated with clogging of the raffinate waste in the evaporator.) The concentrate was then transferred to an available

300,000-gal storage tank with cooling coils, i.e., WM-180, -182, -183, -185, -187, -188, -189, or -190. All non-SBW was eventually calcined to a solid and stored in underground stainless-steel bins (the CSSF).

2.5.1.2.2 Second- and Third-Cycle Raffinates—The composition of second- and third-cycle raffinates is essentially the same for all fuel types processed. The fission product activity in these wastes is low enough that little heat is generated, making cooling unnecessary. The principal nuclides present are Cs-137, Sr-90, and Pu-238. The predominant chemicals in the second- and third-cycle combined waste are aluminum and nitrate. The waste is acidic with a hydrogen ion concentration between 0.1 and 1.6 *M* (INEEL 1998).

Second-cycle raffinates were transferred to the tank farm via a 3-in. line (3"-PUA-2297Y, which was replaced in 1982 by 2"-PUAR 104853). Initially, third-cycle raffinates were transferred to storage tank WM-178 via a 3-in. line (3"- PUA-2401Y) and then to one of three 300,000-gal storage tanks (WM-181, -184, or -186). In 1982, the. 3-in. line, 3"- PUA-2401Y, was replaced by 2"- PUAR 104854, and WM-178 was bypassed, allowing third-cycle raffinates to go directly to one of the three 300,000-gal tanks just mentioned. In 1992, the lines to tank WM-178 were capped.

2.5.2 Waste from Other Sources

While the largest volume of waste originated from fuel reprocessing in CPP-601, waste was shipped to the tank farm from several other facilities. The suitability of waste streams transferred directly to the tank farm was primarily based on laboratory sample analysis prior to processing and process knowledge. Laboratory analysis was performed prior to processing to determine the prescribed operating constraints (e.g., chemical additions, concentrations, flow rate, temperature, chemical addition). On the basis of the pre-process laboratory analysis, process operating constraints, and process knowledge, it was generally known if the waste stream was suitable for the PEW evaporator or if it should go to one of the tank farm 300,000-gal tanks. The PEW evaporator received the dilute intermediate and low-level waste, the PEW evaporator bottoms were transferred to the tank farm for storage. Prior to transfer to the PEW evaporator, waste streams that were of concern due to their source, process knowledge, or likely constituents (e.g., fluoride, chloride, sodium) were analyzed for a limited number of analytes of concern prior to transfer to the PEW evaporator to ensure the PEW evaporator acceptance criteria were met. The process flow of historical fuel operations at INTEC is illustrated in Figure 2-23. A map showing the facility sources of waste stored at the tank farm is provided in Figure 2-24.

Types of waste shipped to the tank farm through the PEW facility include the following:

- Fluoride- and cadmium-bearing waste from the FDP (from the Fluorinel Dissolution Process and Fuel Storage [FAST] facility at CPP-666 through the Fuel Process Building [CPP-601])
- Waste from the fuel storage basins (in FAST and the Fuel Storage Facility in CPP-603)
- Decontamination waste containing fluoride from the waste calcining process (from the WCF at CPP-633 and later the NWCF at CPP-659)
- Waste from occasional transfers from the West Side Holdup Facility in CPP-641 (tanks WL-104 and -105), the pilot plant in CPP-637, and the headend process plant in CPP-640
- Waste generated at the Remote Analytical Laboratory (CPP-684) and the Analytical Laboratory located in the Main Processing Facility (CPP-601/602)

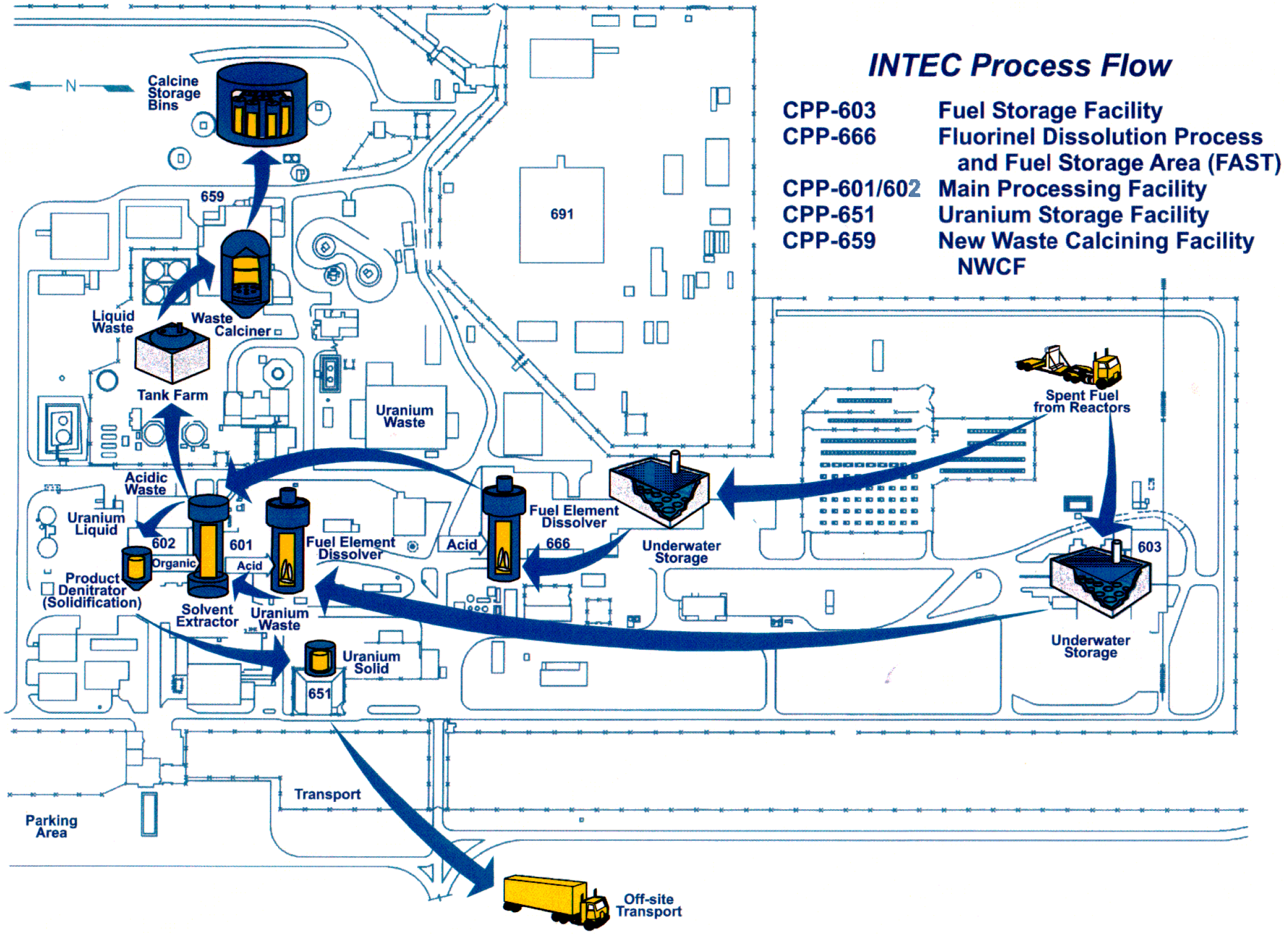


Figure 2-23. The process fl of historical fuel operations at INTEC.

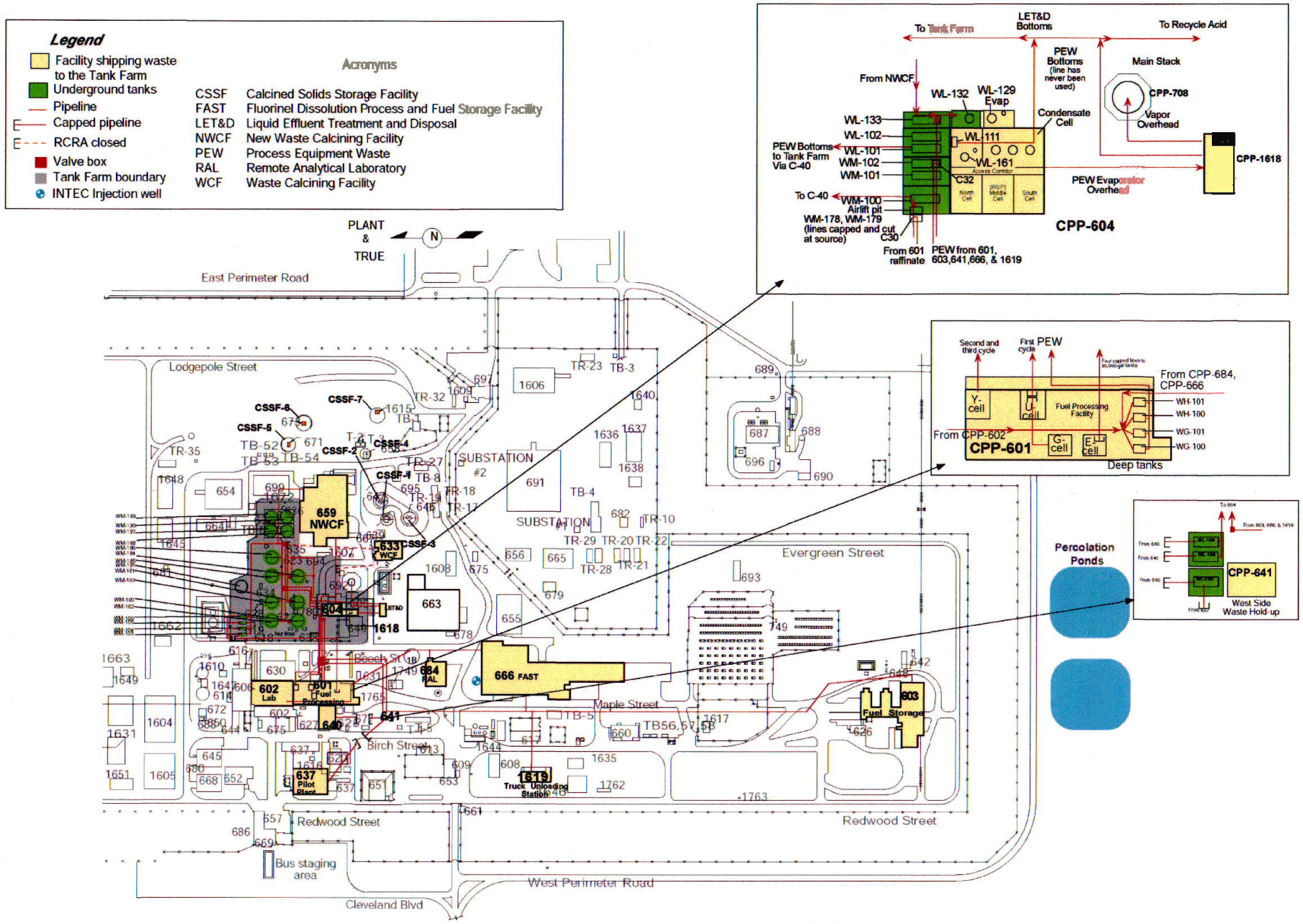


Figure 2-24. Facilities that were sources of liquid waste stored at the tank farm.

- Chlorinated solvents used for degreasing from maintenance operations from the Maintenance Hot Shop in CPP-663

- Non-INTEC waste such as from Test Area North or the Test Reactor Area through the numerous truck unloading stations such as CPP-1619 at INTEC

- Decontamination and other incidental waste from the Liquid Effluent Treatment and Disposal Facility in CPP-1618.

Of the facilities mentioned in the bullets above, FAST (CPP-666), the Fuel Process Building (CPP-601), the WCF (CPP-633), the NWCF (CPP-659), the pilot plant (CPP-637), the headend process plant (CPP-640), the Remote Analytical Facility (CPP-627), and the Hot Shop (CPP-663) are inactive. These facilities are, or will be, decontaminated, dismantled, and closed.

To ensure compatibility with equipment in the raffinate streams, all hazardous waste was analyzed for the analytes of concern (i.e., not for RCRA characterization) before it was processed. Liquid waste was segregated according to chemical composition and stored in separate vessels. When space was limited, waste was combined if analysis determined an undesirable chemical reaction would not occur.